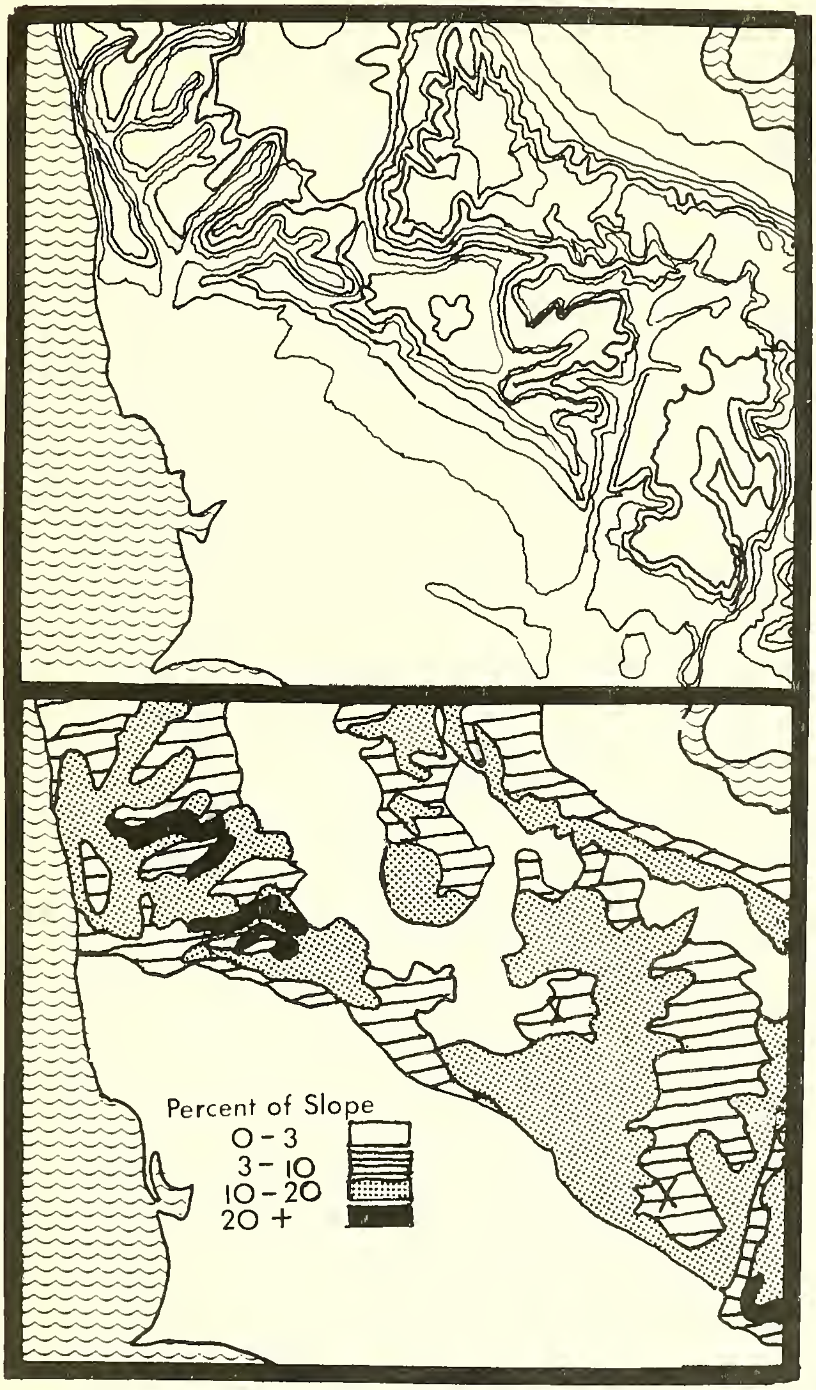
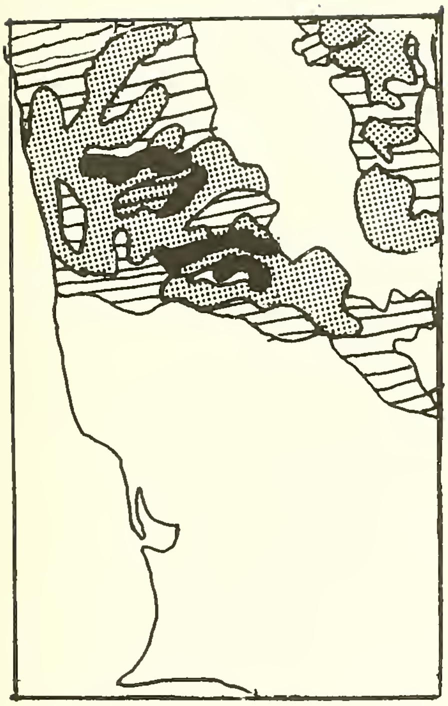


TOPOGRAPHIC SLOPE

technical series
GENERALIZED LAND USE PLAN
august 1974

Maryland Department of State Planning



TOPOGRAPHIC SLOPE

Publication

Maryland, Department of State Planning

TECHNICAL SERIES AUGUST 1974
GENERALIZED LAND USE PLAN

HONORABLE MARVIN MANDEL
GOVERNOR OF THE STATE OF MARYLAND

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ABSTRACT

This publication is a part of the land capability analysis of the Maryland Generalized Land Use Plan. It is designed to be used with a series of county slope maps. The manual explains the significance of slope, or gradient, as a factor in land use and briefly describes slope patterns in Maryland. In addition, this manual explains how slope maps designed for the Land Use Plan were derived from State Highway Administration slope maps and Maryland Geological Survey Topographic maps.

The preparation of this document was financed in part through a comprehensive planning grant from the Department of Housing and Urban Development, as administered by the Maryland Department of State Planning.

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PREFACE

The legislation creating the Maryland Department of State Planning (Articles 41 and 88C, Annotated Code of Maryland) assigns to the Department the responsibility of preparing and updating "a plan or plans for the development of the State, which plan or plans collectively shall be known as the State Development Plan."

Numerous special studies and projects have been or are being completed by the Department of State Planning, including a study of the Chesapeake Bay, a study of State Wetlands, an Outdoor Recreation and Open Space Plan, and an Historic Preservation Plan.

In addition, the Department of State Planning is preparing a State Development Plan; this plan seeks to guide the future development of the State, assuring the welfare and prosperity of the people of Maryland. Studies of social, economic, and physical conditions and trends in the State will be the basis of this plan. The plan as presently defined has two major elements, the Land Use Plan and the Human Resources Plan; the State's physical resources and the well-being of its citizens are emphasized equally.

The Land Use Plan will describe desirable general patterns for the development of land related facilities and services, as well as suggest policies for the management of the State's natural resources. It will include:

1. a statement of the goals, policies, standards and criteria upon which the plan is based;
2. recommendations for the most desirable general pattern of land use in the State;
3. recommendations for major transportation facilities and services in the State;
4. recommendations for major public facilities and services;
5. recommendations for actions to implement the plan.

The development of the land use plan was based upon four assumptions:

1. the plan sets the State policy for land resources, facilities, and services;
2. the plan considers the State's characteristics, land resources, and citizens' needs and aspirations;
3. the plan selects priorities;
4. the plan, as well as the process of forming it, can change the future quality of life and growth of the state.

Several phases are necessary to prepare the Generalized Land Use Plan:

1. preliminary research and analysis
2. capability analysis
3. suitability analysis
4. goal and policy formulation
5. preliminary developments of land use plan alternatives
6. review of alternatives and final plan selection.

The capability/suitability phases form the heart of the plan. This information makes planning possible. Within the context of the Land Use Plan, capability refers to the ability of land to support particular uses based upon the relevant physical characteristics of the land. Capability analysis selects the most important factors for specific land uses, then identifies areas of the State which can best support those types of land use. Capability factors studied are:

1. topography
2. floodplain delineation
3. soil characteristics
    a. agricultural productivity
    b. erosion susceptibility
    c. permeability
    d. depth to bedrock
    e. depth to water table
    f. stability
4. wildlife and fish habitats
5. forests by type
6. geological setting

    a. type
    b. hardness
    c. stability of cuts
    d. durability
7. aquifers
8. mineral resources
9. unique natural features and scenic areas
10. surface water quality

In addition to capability factors, the desirability of particular land uses is based on existing and proposed land-related services. Suitability analysis consider capability factors as well as:

1. existing and proposed land use
2. existing and proposed sewer and water service
3. existing State and Federally owned lands
4. existing and proposed transportation facilities
    a. airports
    b. road intersections
    c. pipe line right of ways
    d. high voltage electric line right of ways
    e. ship channels
    f. rapid transit right of ways
5. existing local and regional plans
6. historical structures or areas

For reasons of economy, no new data was gathered in the preparation of these capability/suitability analyses. Existing information was converted into suitable formats and,,within this constraint, every effort was made to correlate the diverse data sources.

The slope manual is one of a series produced with the capability/suitability analyses of the Land Use Plan. Hopefully, the data in these manuals will be clear to those who read it. The Department of State Planning welcomes suggestions. In the public sphere, perhaps more than in any other , an understanding of the means of a plan is as important as that of the ends; both must be understood if a plan is to be truly effective. These manuals aim for such clarity.

I. INTRODUCTION

The degree of slope, or gradient, is a significant land use capability variable. A more direct relationship exists between slope and several other capability variables than is at first apparent. For example, slope was one of the factors in the Natural Soil Group Mapping System (see Natural Soil Groups of Maryland, Technical Series, Department of State Planning publication No. 199). Change in gradient is also an indicator of drainage patterns (see Surface Water Quality Characteristics, Technical Series, Department of State Planning publication No. 208). In addition, slope if often associated with geological formations (see Geology, Aquifers, Minerals, Technical Series, Department of State Planning publication No. 205) and the occurrence of unique natural features and scenic areas.

Understanding elevation patterns is also useful when they are viewed alone. For example, the slope of farmland will influence both the type of crops grown and the methods of cultivation used. In cities, slope of the land can enhance a structure's utility and beauty or prevent its construction.

Slope is best understood within the context of the topography of the area under study. For instance, two areas may both be flat, yet one is subject to flooding, one is not; the first may lie near a stream; the other, at the top of a plateau. One must know not only the slope of the land, but where a land area is located (land form).

Most land forms are products of one or more erosional agents. wind, ice, waves, and running water. The earth's surface changes in response to physical and chemical processes such as rock decay, downslope movements of soil and rock by gravitational force, and elevation of continental masses by upheavals or warping. Any landscape is a picture of the interplay between these processes.

II. SLOPE PATTERNS IN MARYLAND

Generally speaking, slope categories descend in order from the ridge line into the valley. Greatest changes in gradient occur near the top of the ridges. Valley floors usually show the smallest change in gradient.

The fall line is an imaginary line that marks the end of the Piedmont Range and the beginning of the Coastal Plain. The Maryland counties which straddle the fall line show a typical pattern of gentle through moderate to steeply sloping areas. However, distribution is skewed to the middle two phases (3-10%. 10-20%) of moderate slopes. To the west of the fall line a transition takes place. Wide valleys are interspersed with wide ridges, each exhibiting a respective predominance of low and high slope classes. To the east, on the Upper Eastern Shore, as one heads south, the slope pattern changes from a varied pattern to one dominated by flat land except in areas near a stream where sediments are sharply eroded.

Since the valleys within Western Maryland are narrow, the mildest slope phase 0-3% occurs infrequently. However, on the Lower Eastern Shore steep phases seldom occur. In fact, Dorchester, Wicomico, Somerset and Worcester Counties are generally characterized as having little physical relief (0-3%). Generally western shore counties vary in landscape because of frequent water courses. The degree of dissection varies as well as the amount of topographic variation. This region is best characterized by the occurance of the entire range of slope phases.

Several techniques can be used to display the three dimensional character of the land. These include shading, altitude tints, hachures, contours, and slope phase indicators. Topographic maps using the contour technique are most common. Maps of this type may contain only contours and contour intervals (figure 1) or contain supplementary cultural features as well (figure 2).

A <u>contour</u> is defined as an imaginary line on the ground, every point of which is at the same altitude, or elevation. Contour lines on maps are the graphic representations of ground contours. The lines are drawn at specified elevations or intervals of equal elevation changes such as 20, 40, 60, 80,100, feet above sea level. A series of contour lines not only gives a visual impression of topography but supplies accurate information about true elevations.

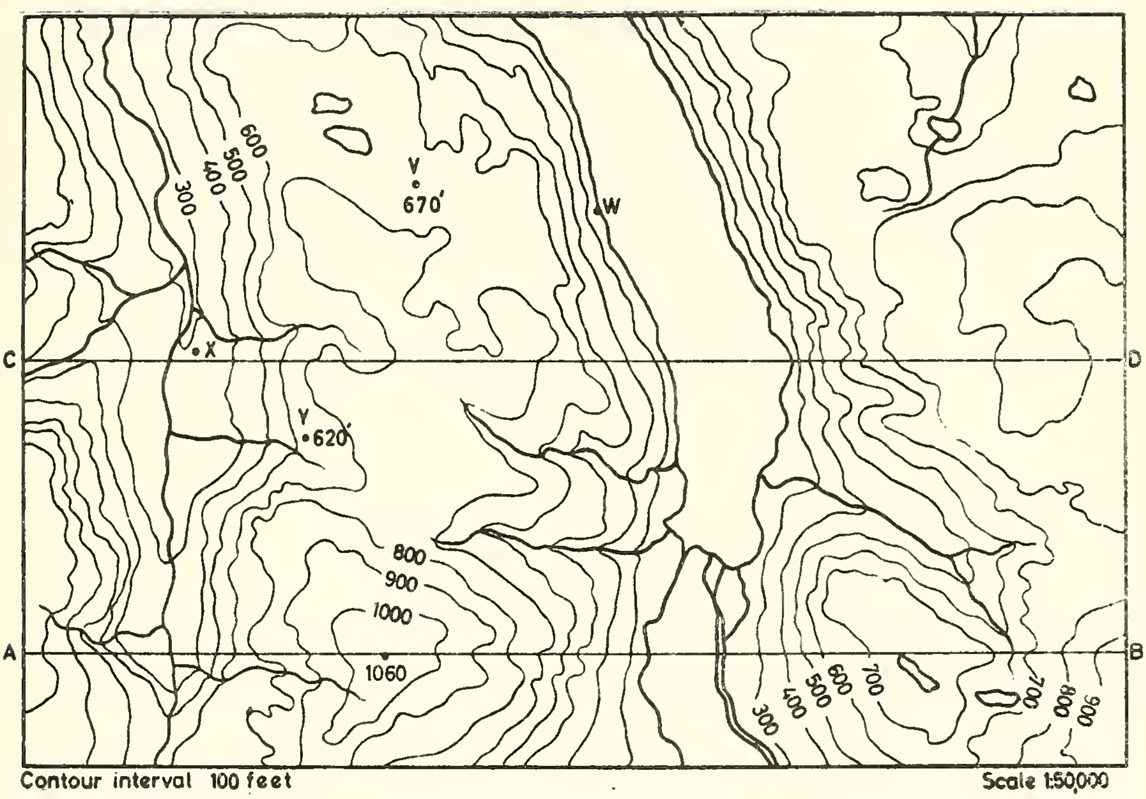


FIGURE 1

Sample Slope Map Segment with Contour Lines and Intervals Only

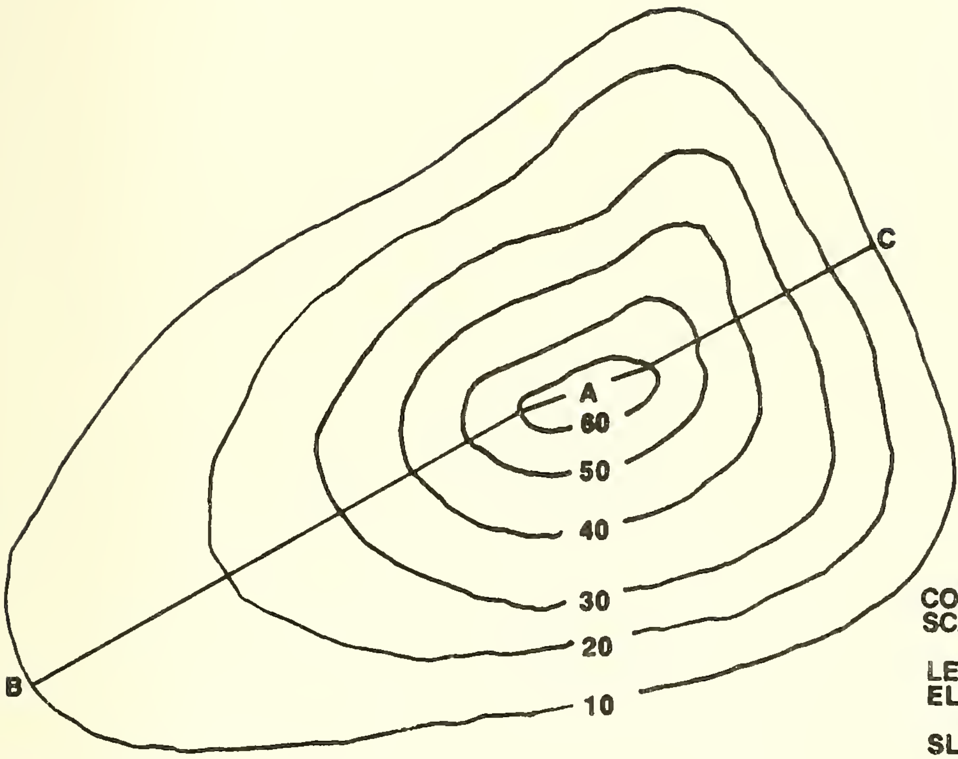
FIGURE 2

Sample Maryland Geological Survey Topographic Map Segment with Cultural Features

Contour interval is the vertical distance between successive contours. The interval remains constant over an entire map. The map legend will describe the full information on the contour intervals used. Because the vertical contour is fixed, horizontal spacing of contours varies with changes in land slope. The general rule is: close crowding of contour lines represents steep slope, wide spacing represents a gentle slope. The gradient of a slope is the ratio of the vertical distance (measured perpendicular to the ground) to the horizontal distances (figure 3). Slope categories are usually expressed in two ways, by percent or degree. The Department of State Planning uses the percentage system for its maps.

Slope maps are more limited in value than the topographic contour maps. However, technical and economic practicalities prevented the use of detailed topographic data in the Department's computer information base. Slope maps were a worthy substitute given the nature and scale of the Generalized State Land Use Plan. Slope maps prepared by Department of State Planning, as described in a later section, recognized four slope phases: 0-3%, 3-10%, 10-20%, and slopes in excess of 20%.

FIGURE 3: Contour Interval Example



CONTOUR INTERVAL 10'
SCALE 1" = 1000'

LENGTH OF LINE A-B = 1.5" = 1500'
ELEVATION CHANGE 60' - 10' = 50'

$$\text{SLOPE(A-B)} = \frac{50}{1500} = 3.3\%$$

LENGTH OF LINE B-C = .5" = 500'
ELEVATION CHANGE 60' - 10' = 50'

$$\text{SLOPE(B-C)} = \frac{50}{500} = 10\%$$

III. DATA COLLECTION AND MANIPULATION

The source of the slope maps was the Map Distribution Office, State Highway Administration, Brooklandville, Maryland. These maps are a part of Maryland Engineering Soil Study's series which included a final report and supporting tables. Maps, tables, and final report were produced in 1965 by the Civil Engineering Department of the University of Maryland for the (then) State Roads Commission.

The State Highway Administration Slope Map Series was improved by Department of State Planning staff and consultants under contract to the Department. The original maps (see figure 4) identified three slope phases (0-3%, 3-10%, greater than 10%). A fourth slope groups was added, which essentially split the third classification (greater than 10%) into two parts -- slopes of 10-20% and slopes greater than 20%. (see figure 5). For ease of publication, the maps were reproduced with numbers designating various slope phases (see figure 6).

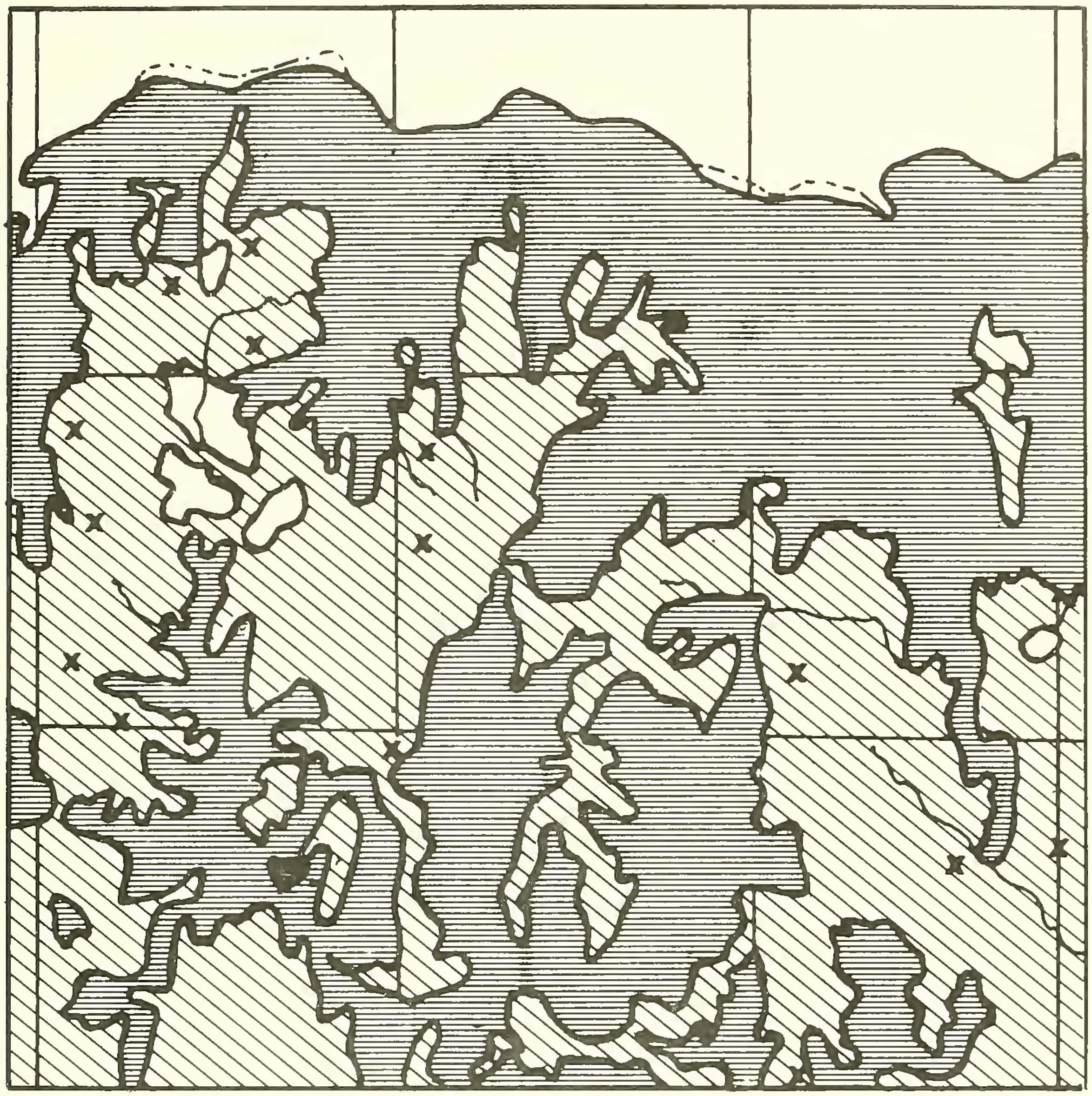
This improvement was achieved in the following manner. First, a complete series of Maryland Geological Survey Topographic maps with an area scale of 1:62, 500 was obtained. Figure 2 contains a sample map segment. Then a Slope Indicator Nomograph showing various contour intervals, divisions per inch, percents of slope, degrees of slope, and slope in feet per mile was obtained (this is an improvement of a Dufour "Hachure Metre" developed in the 19th Century). Figure 7 contains an example of this device. Tracing paper was placed over the topographic maps; the interval measuring device was used to locate those areas with a slope of greater than 20%. For the most part these areas were on ridge lines or steep valley walls, so the amount of each map which had to be surveyed was limited. After the areas of greater than 20% slope were delimited, the tracing paper outlines were transferred to the original slope maps of the same scale. This process was eased because the areas with slopes in excess of 10% were darkened.

Due to the minor scale differences between the two map series (topographic maps 1:62, 500, slope maps 1:63, 360) some shifting of the tracing was necessary to keep it registered with the base map. A scribing tool was used to transfer the outlines from the tracing to the darkened areas of the base map. Subsequently, the outlined areas were filled in with gray-white to silver Prismacolor pencil. (see figure 5)

Completed base maps now have four classifications:

Slope	Map Symbol
0-3%	blank areas
3%-10%	cross hatched
10%-20%	black
greater than 20%	gray-white to silver

FIGURE 4: Sample 1965 SHA Slope Map Segment



GROUND SURFACE SLOPE

0% to 3% gradient

3% to 10% gradient

greater than 10% gradient

X indicates crests of hills

streams indicate toe of slopes

FIGURE 5: Sample 1965 Slope Map Segment (Revised)

GROUND SURFACE SLOPE

0% to 3% gradient

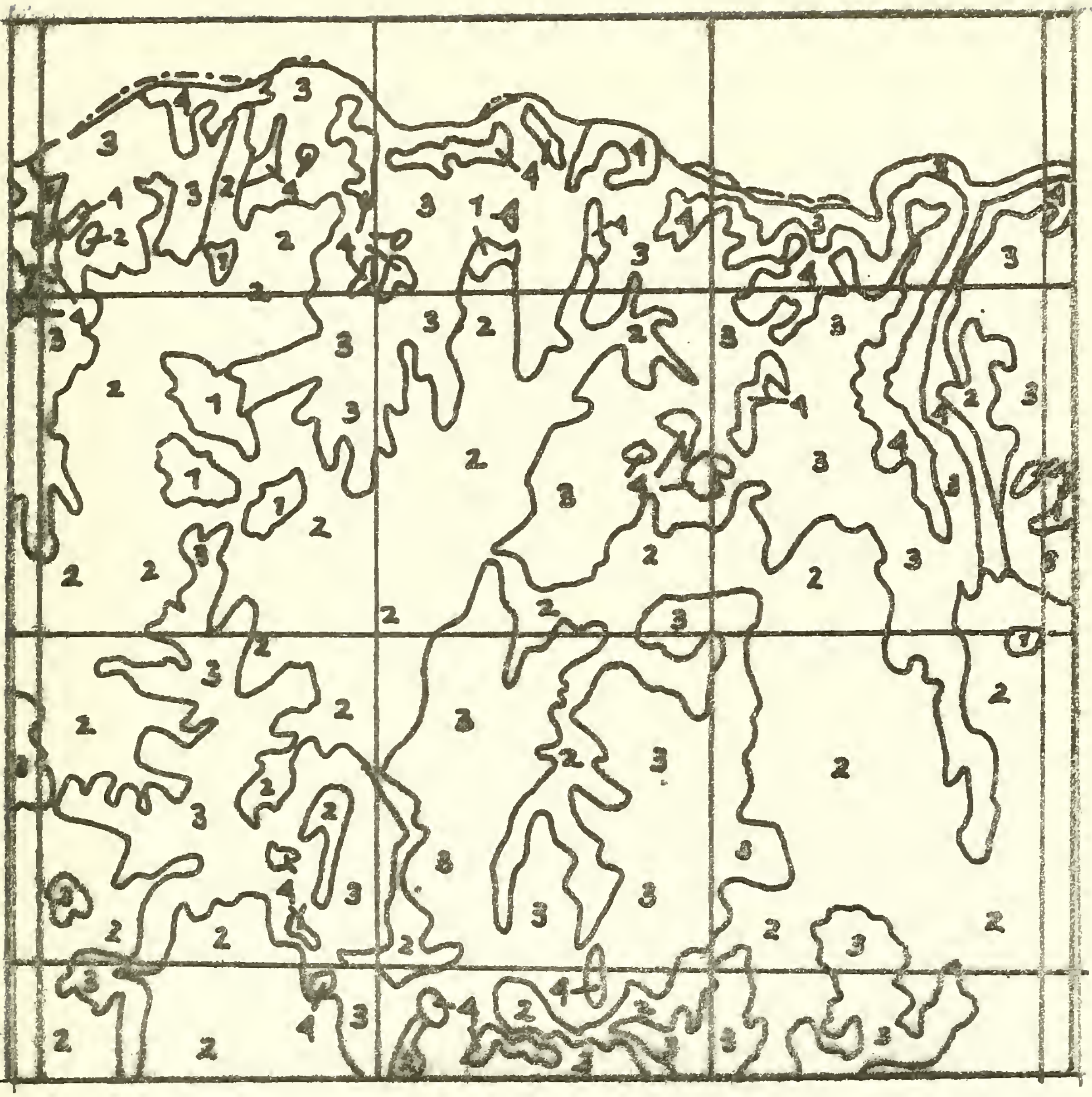
3% to 10% gradient

10% to 20% gradient

silver — greater than 20% gradient

X indicates crests of hills

streams indicate toe of slopes



GROUND SURFACE SLOPE

1 0% to 3% gradient

2 3% to 10% gradient

3 10% to 20% gradient

4 greater than 20% gradient

FIGURE 6
Sample 1965 Slope Map Segment (Revised for Publication)

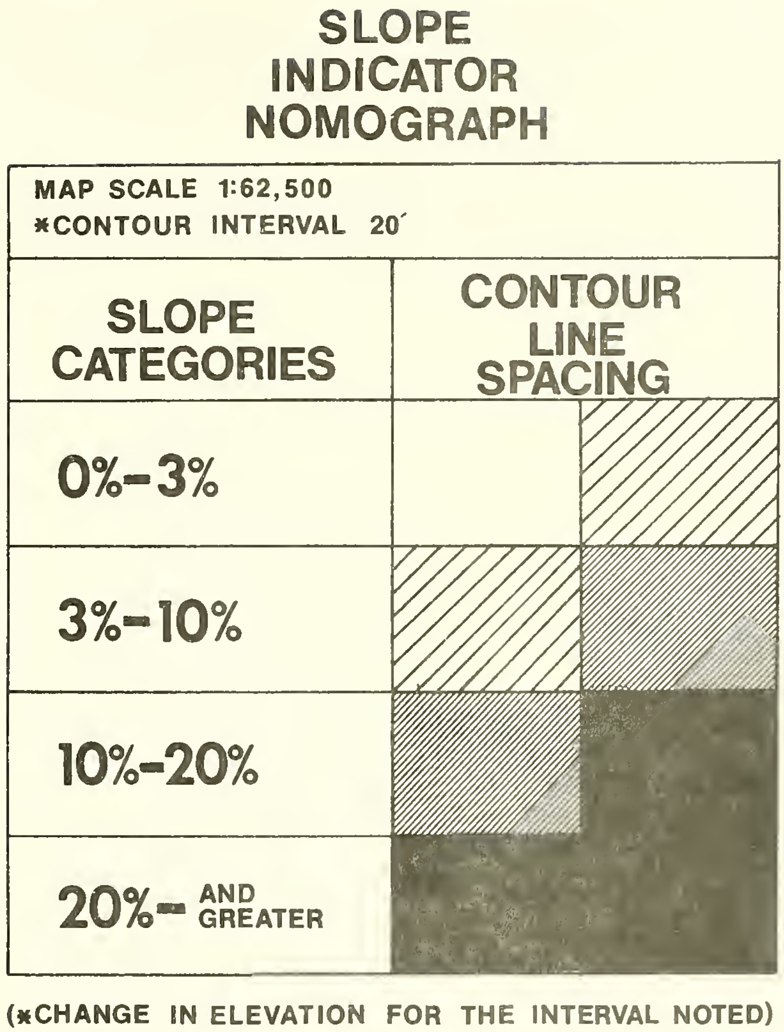


FIGURE 7: Slope Indicator Nomograph

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APPENDIX:

Production of S H A Slope Maps

From Maryland Engineering Soil Study, December 1965

Slope mapping was done by counties. Nineteen counties, (all except Dorchester, Somerset, Wicomico and Worcester) were found to have sufficient variation in topography to make a slope map effective.

The value of the slope maps was increased by indicating stream courses serving as the toe of slopes and also crests of hills. These maps might substitute for topographic maps at a scale of 1" = 1 mile or smaller, at least in planning stages.

Three ranges of surface slope have been plotted:

1. 0 to 3 percent
2. 3 to 10 percent
3. Greater than 10 percent

No table of properties was required.

The Slope Maps proved the most time consuming of the maps produced for the Engineering Soil Study.

A summary of the production procedure follows:

1. Topography of the U. S. Geological Survey $7\frac{1}{2}$ minute quadrangles was converted to slope using a transparent guide with circles representing the horizontal projection of the slopes specified above. The guides were moved along the spaces between the contours until tangency was reached. The radii represented the boundaries between two specific slopes. A smooth curve was drawn surrounding each of the three slope areas and each was marked by its slope type. The Maryland Plane Coordinates were drawn to serve as control. This step was performed on a drafting film overlay.

2. The overlays from above were photographically reduced to a scale of 1" = 1 mile.

3. A drafting film negative was drawn. All areas were opaqued except those having the steepest slope.

4. This negative and a hatching-screen (made by the staff) were double-contact printed on film with one side matte. This processed positive furnished the hatched steepest slope.

5. The intermediate slope was drawn using a ruling-guide. The State Plane Coordinates and sheet borders were also drawn.

6. Typography - coordinates and x's, to indicate crests, were added.

7. Title blocks and legends were taped in place on the overlay. This overlay and the county drainage were double printed on drafting film. This film became the master (Scale: 1" = 1 mile).